MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

ERL1036 – ELECTRICAL CIRCUITS

(B.Sc. Intelligent Robotics)

14 JULY 2023
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **FIVE** pages including cover page with **FOUR** questions only.

2. Answer **ALL** questions and print all your answers in the answer booklet provided.

3. All questions carry equal marks and the distribution of the marks for each question is given.

Question 1

(a) Use **superposition theorem,** determine the voltage, V_{RL} in the circuit shown in **Figure Q1(a).**
(Note: Re-sketch the circuit diagram and show your calculation for each step of the superposition theorem.) [9 marks]

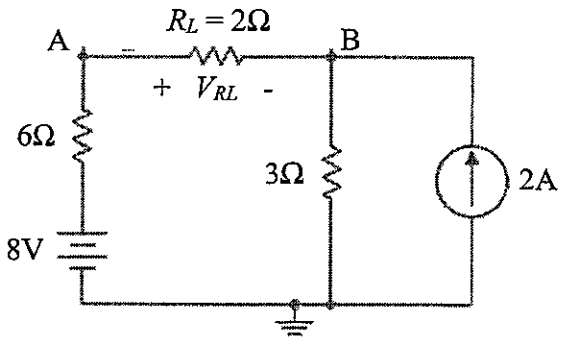

Figure Q1(a)

(b) For the same circuit shown in **Figure Q1(a)**, use **source-conversion theorem** to convert the current source into a voltage source. Then, apply **Thevenin's theorem** on the load resistor, R_L in order to calculate the Thevenin's resistance, R_{TH} and Thevenin's voltage, V_{TH} between nodes **A** and **B**. You are **not required** to use superposition theorem to answer the question.
(Note: Re-sketch the circuit diagram and show your calculation for each step of the source-conversion and Thevenin's theorem.) [9 marks]

(c) Based on the answer obtained in part (b), draw the Thevenin's equivalent circuit and find the voltage, V_{RL}. Assume we need to change the load resistor, R_L in the circuit frequently and analyse the changes of voltage across the load resistor, what is the advantage of using the **Thevenin's theorem** for circuit analysis? [7 marks]

Continued...

Question 2

(a) Determine the node voltages, v_1 and v_2 in the circuit shown in **Figure Q2(a)** using **nodal analysis**. Then, calculate the voltage across the 5Ω resistor, $V_{5\Omega}$ using the node voltages. [11 marks]

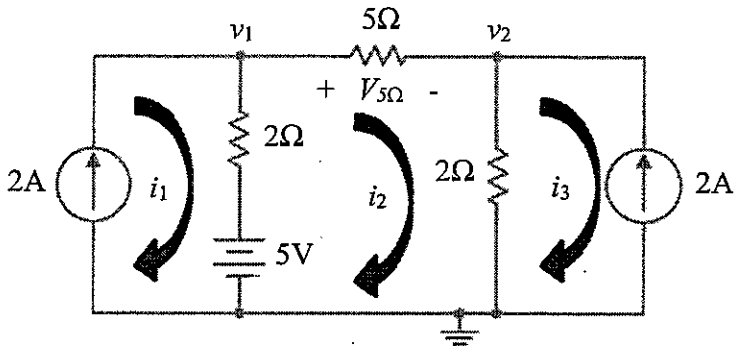

Figure Q2(a)

(b) For the same circuit shown in **Figure Q2(a)**, use **mesh analysis** to determine the mesh current, i_2 given that $i_1 = 2A$, and $i_3 = -2A$. Then, calculate again the voltage across the 5Ω resistor, $V_{5\Omega}$ using the mesh currents. [8 marks]

(c) Is the voltage across the 5Ω resistor, $V_{5\Omega}$ obtained in parts (a) and (b) the same value? Which of the circuit analysis performed in parts (a) and (b) is easier to find the voltage across the 5Ω resistor? Why? [6 marks]

Continued...

Question 3

(a) The circuit shown in **Figure Q3(a)** has a sinusoidal source supply with an angular frequency of 50Hz.

(i) What is the relationship between complex power and average power? Why is it important to measure the average power when constructing a circuit? [5 marks]

(ii) Total up all the impedance, Z_T of the circuit. [8 marks]

(iii) Calculate the total complex power, S. [5 marks]

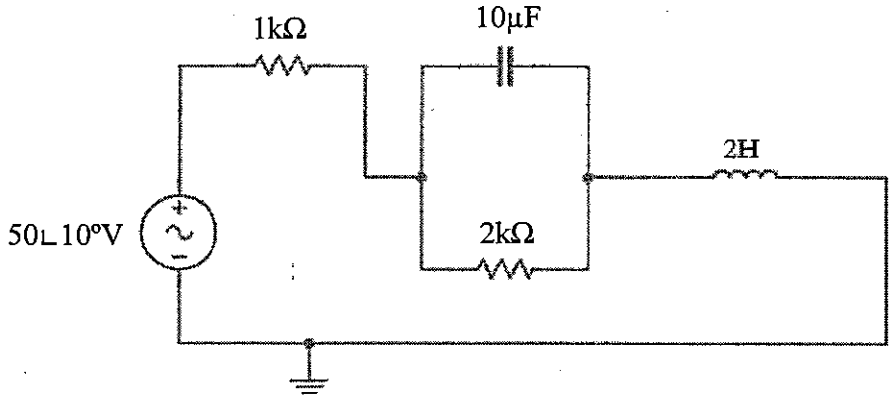

Figure Q3(a)

(b) A parallel resonance circuit has a resistance of 10kΩ, a capacitance of 25nF and an inductance of 10mH. Determine the following:

(i) Resonance frequency, ω and quality factor, Q. [4 marks]

(ii) Is the circuit having high or low quality factor? Why? [3 marks]

Continued...

Question 4

(a) A circuit shown in **Figure Q4(a)** has a switch, **S1** connected to **A** for a long time prior to $t = 0$. At $t \geq 0$s, it changes its connection to terminal **B** and then, at $t \geq 1$s, it switches back to terminal **A** again.

(i) Analyse the circuit by deriving the mathematical expression of the capacitor voltage, $v_C(t)$ for $1\text{s} > t \geq 0\text{s}$ and for $t \geq 1\text{s}$. [11 marks]

(ii) Obtain the voltage, v_C at $t = 1$s and $t = 2$s. [4 marks]

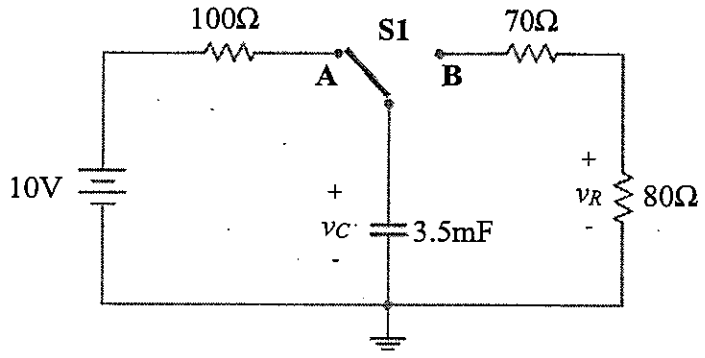

Figure Q4(a)

(b) A source-free **series** *RLC* circuit has a characteristic equation as follows:

$$s^2 + 2s + 10 = 0,$$

(i) Is the circuit exhibits a critically damped, overdamped or underdamped output response? [5 marks]

(ii) How does the output response obtained in part (b)(i) affect the current flow of the *RLC* circuit? How can we improve the output response of the circuit? [4 marks]

End of Paper